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BIRDS, ENCEPHALITIS, AND ECTOPARASITES

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Encephalitis or "inflammation of the brain" is a general term applied to a disorder which may have many causes. Usually this disorder is caused by a virus but it may also be produced by other types of micro-organisms. Encephalitis may also occur after an initial infection with mumps, measles and other childhood diseases, or following a vaccination, or as a result of a non-infectious process such as poisoning.

Since encephalitis affects the brain, which in turn controls all body functions, encephalitis from any cause can show symptoms of general illness throughout the body such as headache, nausea and vomiting, fever, sore throat, and chills. Severe cases begin suddenly and severely and may be followed by stiff neck, drowsiness, trembling, mental confusion, convulsions and coma. Most encephalitis cases recover completely, but others suffer serious after effects such as mental deficiency, spastic or other paralysis, or emotional instability. Some cases die, with babies and the elderly being the most seriously affected.

Treatment is symptomatic in most cases as antibiotics cannot kill viruses which are the most common cause of encephalitis.

Why is encephalitis of interest to you, who are interested in birds, or for that matter, to me, as a medical entomologist?

We have already discussed the many causes of encephalitis and that viral encephalitis is the most common. Viral encephalitis is transmitted in a variety of fashions including those forms transmitted by mosquitoes, and ticks, or the "arthropod-borne encephalitides." Of interest to us today are the mosquito-borne encephalitides, five forms of which occur in the United States. Although mosquito-borne encephalitides, has been known as a disease of man since the 1930's it has only been recently that any effort has been made to separate these encep-phalitides from those following other infections, and hence develop an accurate picture of the importance of mosquito-borne encephalitis.

Western Encephalitis

Western Encephalitis has repeatedly been found in man and domestic animals in the western and middle western states west of the Mississippi. Occasional outbreaks have occurred in states further east and even along the eastern seaboard. Western encephalitis is a disease of the summer months occurring usually

between May and September. It is also a rural disease with 60% or over of all cases occurring in strictly rural areas, and a number of urban cases having been contracted during a visit to the country. Cases of this disease are most common in well-watered and irrigated areas.

The basic cycle of transmission for WE is a bird-mosquito cycle involving both wild and domestic birds. The virus has been isolated from a wide variety of mosquitoes in the field of the genera *Culex, Culiseta, Aedes* and one species of *Anopheles. Culex tarsalis* is the chief vector over the main range of this disease and has been shown consistently present in epidemics, with an adequate population density, feeding mainly on birds, but also readily on animals (including man), and which is commonly infected and can be shown to be a very efficient vector.

While the importance of *Culex tarsalis* as a vector, and the importance of birds as reservoir hosts in the basic cycle are readily established, the most important bird species is very obscure. Published and unpublished records indicate that the *virus* has been recovered from 20 species of birds and 6 species of mammals, and antibodies have been found in more than 75 species of wild birds as well as most of the common domestic birds and mammals.

The virus occurs in man or mammals only when there is a sufficient rate of infection in birds, with a respectively high infection rate in mosquitoes. Mammals appear to be dead-end hosts in transmitting the infection because of low or transient viremia.

Western encephalitis affects people of all age groups with a mortality of 5 - 15% of its victims.

Eastern Encephalitis

Eastern Encephalitis (EE) is endemic along the eastern seaboard into Mexico with some outbreaks in the Middle West.

Outbreaks of this disease occur later in the summer than those of Western Encephalitis, but the number of human cases in a given outbreak are always lower than major WE outbreaks. Most major outbreaks of EE occur between August and October.

Eastern encephalitis also has a bird-mosquito cycle involving many species of birds. *Culiseta melanura* is the principle mosquito vector, but this species feeds mainly on birds and has only been reported as biting man twice. A few isolations of EE have been made from other mosquito species, but thus far no ideal vectors of this virus to man have been reported. An interesting point with EE is the transmission of this virus among pheasants by pecking, requiring all pheasant bills to be chipped to stop transmission.

Eastern encephalitis, although affecting fewer people at one time, affects a disproportionate number of children under 10 years of age, with a two-thirds mortality rate, and a large proportion of survivors suffer permanent brain damage.

St. Louis Encephalitis

St. Louis Encephalitis (SLE) occurs in the United States over the same geographic range as Western Encephalitis, but with more frequent outbreaks in the Midwest, and occasionally along the eastern seaboard.

Whereas Eastern and Western Encephalitis have accounted for large outbreaks in horses over the years, St. Louis Encephalitis has no apparent effect on equines.

St. Louis Encephalitis outbreaks are most common in summer and autumn occurring between the end of June and the middle of October. SLE affects all age groups with a mortality rate of 2 - 10%. The St. Petersburg outbreak had a mortality rate of 22% because the majority of the cases involved elderly retired persons.

The normal cycle of SLE is again a sylvatic cycle of wild birds and mosquitoes. Contrary to EE and WE, however, large outbreaks of SLE have occurred in urban areas in the central states involving species of the *Culex pipiens* complex, or common house mosquitoes. The disease is amplified in nestling and juvenile wild birds (such as the English Sparrow) and domestic fowl. In the Western United States SLE is mainly a rural disease and is transmitted primarily by *Culex tarsalis.*

Other Mosquito-Borne Encephalitides

Two other mosquito-borne encephalitides occur in the United States but are of lesser importance to us here because the reservoir hosts are principally mammals instead of birds. Venezuelan Encephalitis has been found in Southern Florida in man, wild mammals, and mosquitoes. This disease is mainly tropical but poses a serious problem in that respiratory transmission may occur from man to man without aid of a mosquito vector.

The other mosquito-borne encephalitis of man known to occur in the U.S.A. is California Encephalitis Virus (CE). This is a disease of the Midwest and California with more cases isolated in Ohio than any other state. Mosquitoes of the genus Aedes are the primary vectors and small mammals (particularly members of the squirrel and marmot families) are the natural hosts. This disease affects mainly children under the age of 15, and has a mortality rate of less than 1%.

The Relationship of Birds and Encephalitis

Investigations into the feeding habits of *Culex tarsalis, a* major mosquito vector of rural St. Louis Encephalitis and Western Encephalitis show that it most frequently feeds on birds, although it may feed on a variety of mammals, including man, and on reptiles. The breeding places of this mosquito coincide with those of many species of birds, giving a close association between this vector species and the nestlings of many bird species. This also holds true for the urban

cycle of SLE. The domestic house mosquito *(Culex pipiens* complex) breed commonly around the home with ready access to nestlings of the domestic sparrow, pigeon, etc. In one study 50% of the nestling sparrows in an endemic area of urban SLE were found to be serologically positive to this virus.

Although English sparrows, red-winged blackbirds and pigeons are commonly found to have antibodies to Eastern, Western or St. Louis Encephalitis, bird control is not a feasible answer to controlling encephalitis in most cases. During a large outbreak of SLE in Florida prior to the discovery and control of the mosquito vector *(Culex nigropalpus),* the front page of many newspapers printed a large photograph of a robin sitting on a nest with a skull-and-cross-bones and the caption "destroy this killer." The area involved in the epidemic was an elderly retirement village where feeding the birds was a major pastime. This brought infected birds in close proximity to domestic house mosquitoes and man. The bird population in this area had shown a high rate of infection, and when this became generally known, the newspapers jumped to the wrong conclusion (as so often happens). However, by stopping the feeding of the birds, the bird population did begin to scatter. However, mosquito control for the correct vector was undertaken simultaneously making the assessment of this step difficult to weigh.

Bird Ectoparasites

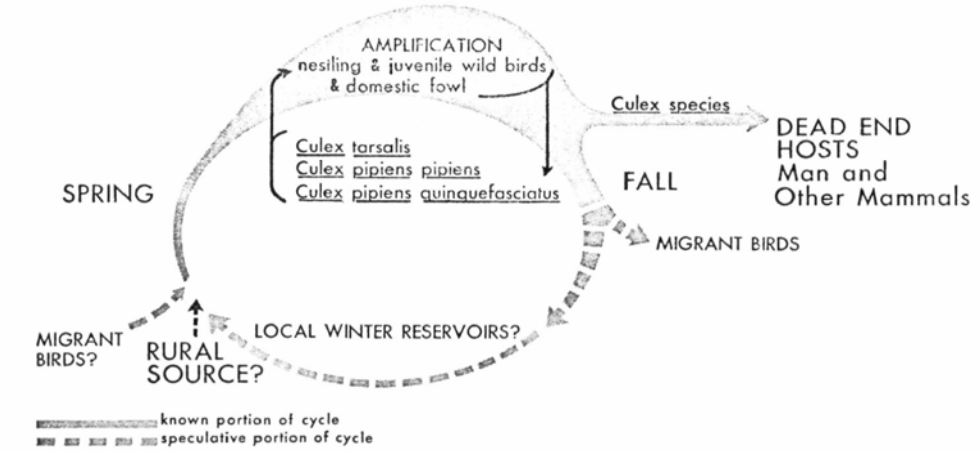
Both Eastern and Western Encephalitis have been isolated from bird mites in the wild including the chicken mite *(Dermanyssus gallinae),* Northern Fowl Mite *(Ornithonyssus sylviarum),* and Tropical Fowl Mite *(O. Bursaj,* and a bird louse (*Eomenacanthus stramineus).* All study into these arthropods as important vectors of encephalitis has been unrewarding, and it seems probable that infection of mites or biting lice means merely that these anthropoids have recently had a meal of infected blood and that virus is surviving in them.

However, bird mites, particularly Chicken mites *(Dermanyssus gallinae),* and less frequently, Northern *(Omythonyssus sylviarum),* and Tropical *(0. bursa)* Fowl mites, will feed readily on man. These mites may swarm from pigeon, starling, and English Sparrow nests in eaves or attics along the outside of buildings and crawl through doors or windows, or through openings in the upper portions of the building to feed on man. Normally, though not always, this occurs after the birds have left the premises because of control of the birds themselves, the destruction of the bird nests, or stopping-up building openings thus, preventing the birds from returning to their nests. The Pigeon Louse Fly *(Pseudolynchia canariensis)* will also bite man and may become a problem.

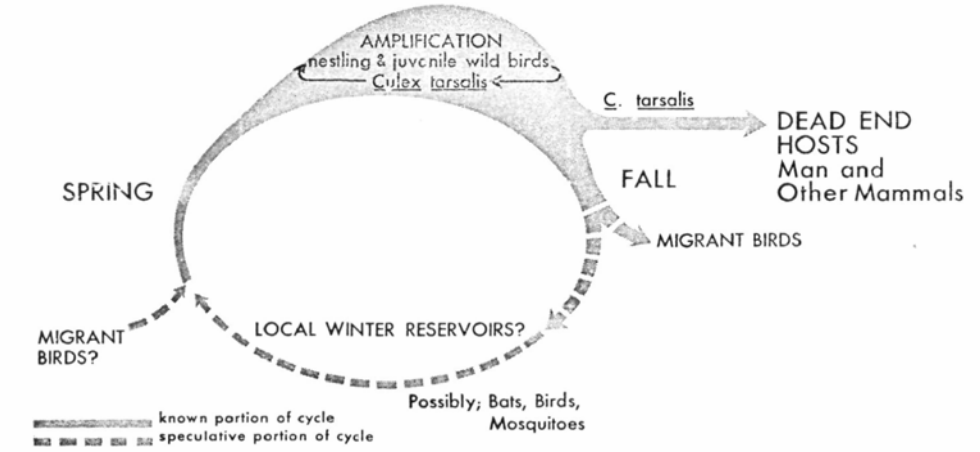
Control of these ectoparasites can usually be accomplished by removal of the bird nests in attics and eaves and applying an acaricidal spray to walls of rooms already invaded. Good results have been obtained with a .5% Lindane spray applied to walls and floors.

In closing it might be of interest to you to see how birds are collected and processed to determine whether or not they are infected with mosquito-borne

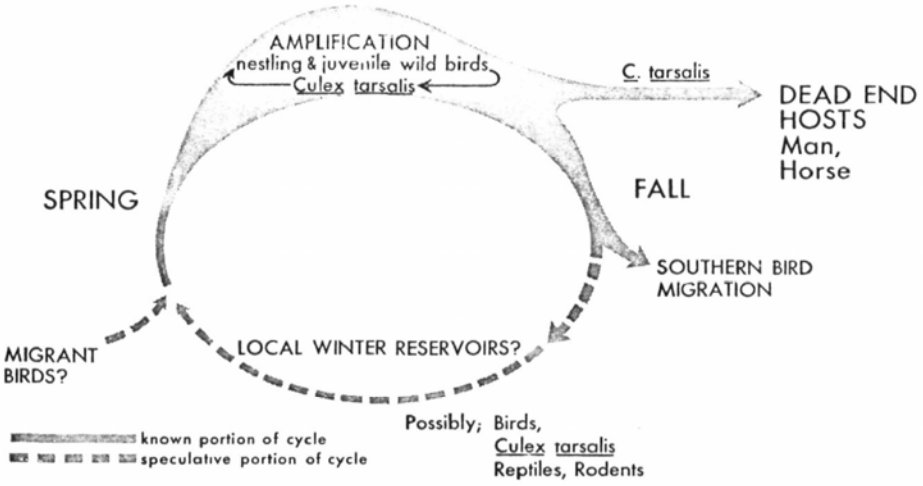
URBAN SLE VIRUS CYCLE



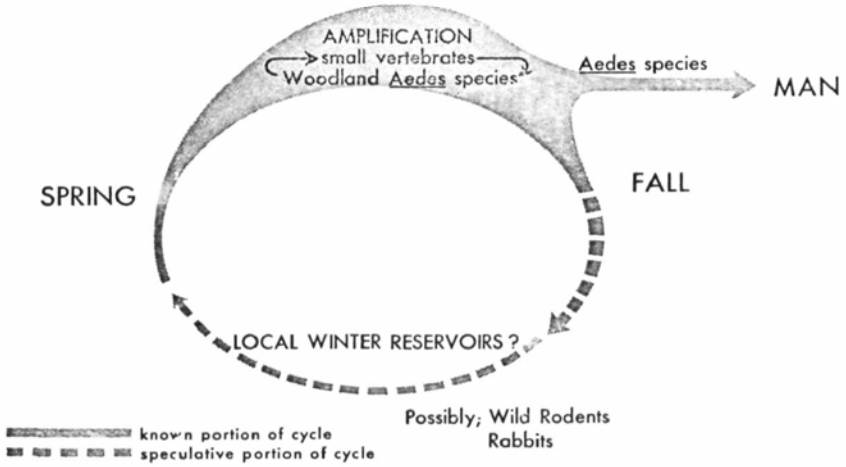
RURAL SLE VIRUS CYCLE- MOSTLY WESTERN U.S.

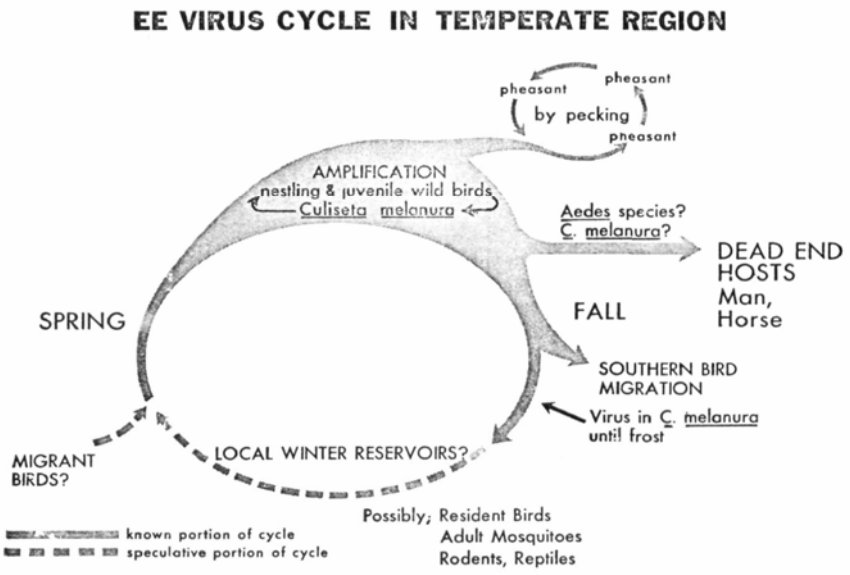


WE VIRUS CYCLE IN WESTERN U.S.



CE VIRUS CYCLE IN EASTERN U.S.




EE VIRUS CYCLE IN TEMPERATE REGION
pheasant
pheasant
by pecking
pheasant
AMPLIFICATION
nestling & juvenile wild birds
Culiseta melanura
Aedes species?
C. melanura?
DEAD END
HOSTS
Man,
Horse
SPRING
FALL
SOUTHERN BIRD
MIGRATION
Virus in C. melanura
until frost
MIGRANT
BIRDS?
LOCAL WINTER RESERVOIRS?
Possibly; Resident Birds
Adult Mosquitoes
Rodents, Reptiles
known portion of cycle
speculative portion of cycle

ENCEPHALITIS IN NATURE AFFECTING HUMANS*

by Harold E. Stark, Paul L. Rice and W. Daniel Sudia

Etiologic Agent	Distribution	Vertebrate Hosts	Arthropod Vectors	Involvement in Man	Disease Severity
Group "A" 1. EE (Eastern Encephalitis)	Eastern Canada, USA, Mexico, Caribbean, Panama, Trinidad, Colombia and Brazil	Wild: Various species of smaller birds e.g., grackle and catbird; perhaps small wild mammals, e.g., cotton rat and reptiles Domestic: Horse, fowls, house sparrow,** and introduced birds such as pheasant and chukar; probably horse is incidental host	*Culiseta melanura* (main bird vector); *Aedes sollicitans* and perhaps other species such as *Ae. infirmatus, Ae. atlanticus, Ae. vexans* and *Mansonia perturbans*	Infrequently	Severe in children; overall mortality in man 60%; severe sequelae; horse mortality approaches 100%; pheasants and other introduced birds - high mortality
2. VE (Venezuelan Encephalitis)	Northern South America (Venezuela, Colombia, Brazil) Trinidad, Panama, Mexico, and Florida	Wild: Small wild rodents appear to be most important; (birds apparently not involved) Domestic: Horse, other equines, goats and other domestic mammals	*Aedes taeniorhynchus, Culex (Melanoconion)* spp., *Ae. serratus, Ae. scapularis*, perhaps *Psorophora confinnis* and *Mansonia titillans*	Infrequently in Florida; extensively in South America; man may become infected through respiratory tract	Mild in man; severe in horses
3. WE (Western Encephalitis)	Canada, USA, Mexico, Trinidad, Guyana and Argentina	Wild: Various species of small wild birds such as blackbirds, catbirds and sparrows; perhaps wild rodents and reptiles Domestic: Horse, fowls, house sparrow;** horse appears to be incidental host	*Culex tarsalis* and *Aedes dorsalis* most important in West; *Culiseta melanura* bird vector in East	Frequently	Severe in children; overall mortality in man 5 to 15%; severe in horses
Group "B" 4. SLE (St. Louis Encephalitis)	USA, Caribbean, Panama and Northern South America	Wild: Various species of birds including flicker, mocking bird and blue jay Domestic: house sparrow,** fowls pigeon; horse may be infected but does not show clinical symptoms	*Culex pipiens, C. quinquefasciatus, C. tarsalis*, and *C. nigripalpus*	Frequently	Severe in old people; overall mortality 2 to 10%; much higher in upper age group; many inapparent infections in man
Group "California" 5. CE (includes (California Encephalitis; includes several strains)	North America	Wild: Rabbits, hares, several species of ground squirrels and perhaps other small rodents; birds probably not involved Domestic: Antibodies found in horses and cows but no clinical illness	*Aedes spp.* such as *atlanticus, canadensis, taeniorhynchus, infirmatus* and others	Primarily appears in children under 14 years of age	Occasionally severe in children; inapparent infections common in man

*Confined to mosquito-borne encephalitides of the western hemisphere

**Although a wild bird, the house sparrow commonly nests in domestic situations and its habits are "para-domestic."

DHEW, PHS, BDPEC, CDC, 1967

Summary of the Major Mosquito-borne Encephalitides,
1964-1966

Eastern

State	Cases
New Jersey	1
Maryland	1
North Carolina	1
Georgia	7
Florida	7

California

State	Cases
New York	1
North Carolina	4
Ohio	106
Indiana	21
Illinois	1
Wisconsin	32
Iowa	6
Minnesota	14

Western

State	Cases
Arizona	1
California	28
New Mexico	8
Texas	55
Colorado	90
Wyoming	12
Montana	15
North Dakota	26
South Dakota	5
Nebraska	6
Kansas	18
Minnesota	7

St. Louis

State	Cases
California	11
Arizona	7
Nevada	1
Texas	511
Colorado	47
Wyoming	1
Montana	1
South Dakota	2
Nebraska	4
Kansas	23
Minnesota	3
Missouri	17
Arkansas	1
Louisiana	7
Mississippi	1
Tennessee	6
Illinois	45
Michigan	1
Indiana	18
Ohio	2
Pennsylvania	22
New Jersey	96

State	Cases
Missouri	7
Wisconsin	1
Illinois	2
Indiana	1
Michigan	1

encephalitis. The Japanese Mist net is the most common method used to collect 1 large numbers and varieties of birds. Once a bird is captured it is banded with regulation Fish and Wildlife Service leg bands. A small blood sample is removed and the bird is then released. Using a combination of unknown sera from the birds with antigens, the known viruses themselves, and red blood cells, it is possible to determine what antibody, or virus infection, a given bird may exhibit.

DISCUSSION:

CORLAND: What is the host during the winter period?

PARSONS: We'd all like to know.

CORLAND: What about the studies done with snakes in Utah?

PARSONS: There has been some evidence that cold-blooded vertebrates, particularly snakes, may be an over-wintering mechanism. They have found the antibodies in the snakes in some areas. However, in studies run with snakes where they have actually injected virus into them, and put them in a hibernating situation and then taken them out, in most cases they have lost the virus. It hasn't returned. In order to overwinter, in other words, it has either got to drop down or maintain a level; but when the mosquitoes come out in the spring it's going to have to pick up again in a high stage of viremia in order to transmit it to the mosquitoes. And so far there isn't enough concrete evidence to point to any one method. Now on the bird-borne encephalitides, they're still pointing strong fingers at migrations. The U.S. Public Health Service has been doing a constant string of studies in the northern part of South America, getting the spring migration as it moves north and running thousands of sera samples through to test for the presence of virus before it gets to this country. Their results are beginning to show a trend. This, of course, doesn't help us with California or Venezuelan Encephalitis which is here.

STOCKDALE: I'd like to make a little plug for Peg's agency and my own, the Cooperative Extension Service. We have just completed the compilation of an Ohio Mosquito Manual which is available from the Cooperative Extension Service. We have just completed the compilation of an Ohio Mosquito Manual which is available from the Cooperative Extension Service. I'd be happy to show you a copy of it and you may want to get copies for yourselves from the Cooperative Extension Service, Ohio State University.